Chapter Six
Edge Effects

A. Introduction

"Edge effects" is a general term for a variety of impacts to natural communities across a boundary with a modified landscape, such as agricultural fields or urban development. Many studies of edge effects have examined the forest-grassland boundary and documented changes resulting from altered light, temperature, and wind. In scrub communities in an urbanizing matrix, edge effects result primarily from the impacts of human activities and influences, rather than changes in physical environmental processes. Edge effects reduce the effective size of preserves by reducing the area in which ecological processes continue without substantial modification.

Rotenberry and Kelly (1993) list several potential edge effects to habitat reserves in southern California, including:

- introduction of alien predators, particularly domestic cats;
- introduction of competitors (rats and mice);
- disease transmission from domestic or commensal animals to wildlife;
- trespass and associated habitat alteration;
- increased levels of nighttime illumination;
- increases in sound and vibration levels.

The first three of these "edge effects are biologically-mediated and have the potential to impact the entire area of the preserves, not just the edges. Replacement of native plant communities by exotic vegetation may be added to the list of these biological edge effects.

Habitat alteration by trespassers is a direct human impact. Unauthorized uses of the preserves, for mountain biking and other potentially destructive sports activities, may be included in this group. These impacts will be concentrated in those areas that are most accessible to the general public.

The last two edge effects listed may be termed physical effects and, like physical changes to forest edges, are limited in impact to relatively limited, peripheral areas of the preserves.

The impact of these edge effects, and the ultimate value of these preserves as wildlife habitat, depends on the extent of human impacts to the surrounding landscape, their direct and indirect effects, and the proactive measures taken to ameliorate these effects.

B. Impacts to the Surrounding Landscape

In 1990, land use in the vicinity of the Preserves was primarily undeveloped lands and extensive agriculture. In the last decade residential development has begun to change the area (Figures 6-1 and 6-2), and this process will continue until Carmel Mountain and Del Mar Mesa are "habitat peninsulas," areas with development along most of their perimeter, but retaining a degree of connectivity with other habitat areas.

The Carmel Mountain Preserve was about 300 feet from the nearest residential

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development, near the southwest corner of the Preserve (San Diego Association of Governments [SANDAG], Land Use 1990 GIS coverage). By 2000, housing was adjacent to the southwest corner, and within 600 feet of the preserve at points along the southern and eastern sides. Land use plans call for multi-family housing adjacent to the west and north sides of the Preserve, and single-family housing adjacent to the south side (SANDAG Planned Land Use GIS coverage). To the east, a mix of housing, golf courses, and wildlife corridors are in place that will produce relatively minor edge effects.

In 1990, the future Del Mar Preserve was about 2,000 feet from the nearest residential development, to the east of the Preserve. By 2000, residential development along three-quarters of the Preserve's southern side and within 1,500 feet of its eastern side had been constructed. Planned land use for the area calls retail and strip commercial development adjacent to the east side of the Preserve, and rural residential development to the west. The Del Mar Preserve will be linked to habitat corridors to the north and south.

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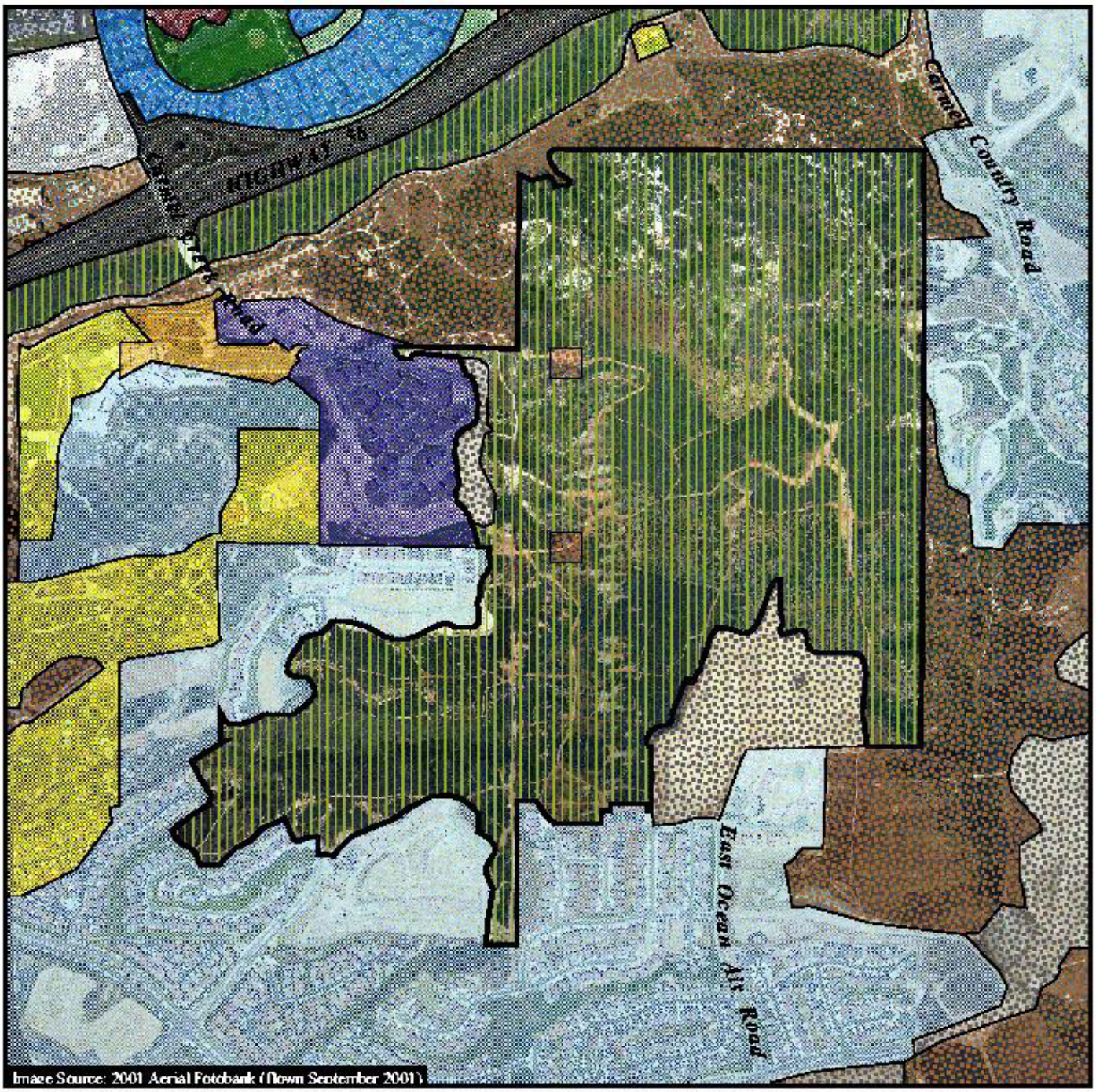
C. Biologically Mediated Impacts

The increase in human population adjacent to and near the Preserves will inevitably lead to degradation of their habitat value from indirect human impacts, unless measures are taken to counteract the biologically mediated edge effects.

1. Introduced Predators

Domestic and feral cats are a major threat to populations of small mammals and birds in small reserves in southern California, where domestic cats have been observed up to one mile from human dwellings (Kelly and Rotenberry 1993). If this pattern holds true on these reserves, this "edge effect" will affect the entire area of both Preserves.

Birds, mammal, and plant species extirpations in habitat fragments (from 10 to 230 acres in size) have been observed or deduced, based on the size of habitat patches



Carmel Mountain Preserve

Land Use (SANDAG, 1995, modified by Recon, 2001)

- Open space reserves, preserves
- Landscape open space
- Parks - active
- Spaced rural residential
- Residential
- Single family residential
- Multi-family residential
- Elementary schools
- Community shopping centers
- Orchards and vineyards
- Vacant, graded land
- Vacant, not graded land
- Freeways

0 Feet 1000

FIGURE 6-1

Land Use
Carmel Mountain Preserve

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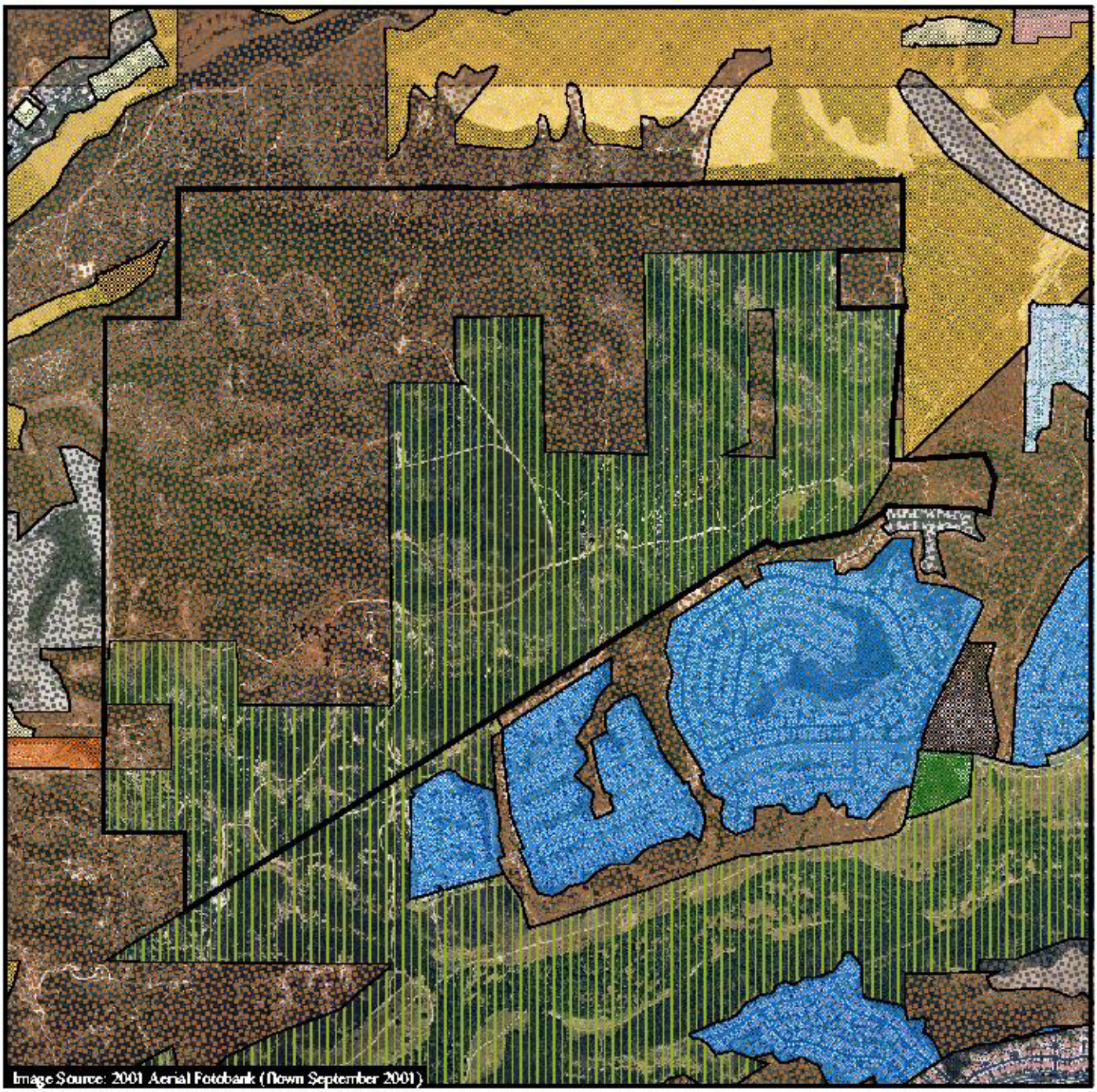

Del Mar Mesa Preserve

Land Use (SANDAG, 1995, modified by Recon, 2001)

- Open space reserves, preserves
- Parks - active
- Spaced rural residential
- Residential
- Single family residential
- Elementary schools
- Junior high schools
- Field crops
- Intensive agriculture
- Vacant, not graded land
- Vacant, graded land

0 Feet 1500

FIGURE 6-2

Land Use
Del Mar Mesa Preserve

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and length of time since isolation (Crooks et al. 2001; Soule et al. 1988, 1992). Another significant variable contributing to the loss of chaparral-dependent bird species is the absence of coyotes and the presence of gray foxes from isolated habitat. The loss of dominant predators, such as coyotes, is believed to lead to population explosions of smaller predators, such as foxes and domestic cats, that prey on bird species, a phenomenon known as "mesopredator release" (Soule et al 1988).

2. Commensal Animals

Commensal animals refers to small mammals, particularly mice and rodents, that use the same food resources as native wildlife species. Increases in available food resources in the surrounding area (e.g., household garbage) leads to increased population levels for these opportunistic species. Increased populations then expand into native habitat, competing with native wildlife for food resources within the preserves, but maintaining base population levels upon the artificial food sources. During times when food is limited, particularly during drought, commensal animals may out-compete native wildlife for food resources. Commensal animals may also serve as disease vectors, introducing native wildlife to novel diseases associated with humans and their domestic animals.

3. Invasive Plants

Intact native vegetation is generally resistant to invasion, providing few safe sites where non-native seeds can establish. Natural disturbances, such as fire or mammal burrowing, and human-induced disturbances (described below) create opportunities for invasive species to become established. Invasive plant species have the potential to displace native species and eventually dominate the habitat, hybridize with native plant species, provide food and habitat for non-native animal species, and effect ecosystem functions such as nutrient cycling, wetland hydrology, sedimentation, and erosion (Brossard et al. 2000).

Invasive species present on the Preserves and in surrounding wildlands include non-native grasses (*Avena* spp., *Bromus* spp., *Hordeum* spp., *Lolium* spp.), mustard (*Brassica nigra*), and thistles (*Carduus* spp., *Centaurea* spp., *Circium* spp.). Invasive species that may be introduced from residential developments include pampas grass (*Cortaderia selloana*), crown daisy (*Chrysanthemum coronarium*), and other landscape plants.

Most of these exotic species present threats to upland habitats, where they occupy the understory and are unlikely to result in major ecosystem changes in the absence of widespread disturbance. Perennial ryegrass (*Lolium multiflorum*), a non-native grass species, is adapted to moist soil conditions and has a high potential to invade the fringes of vernal pools and other ephemeral wetlands, even in the absence of additional habitat disturbance.

D. Direct Human Impacts

Unregulated human activities that may reduce habitat quality include trespass and creation of unauthorized trails, mountain bicycle and motorcycle use, building temporary habitations, and fire. Currently, the impacts of mountain bicycles, motorcycles, and horses appear to be the most extensive landscape impact. Soil disturbance from these activities provides safe sites for exotic plant species to become established and increases soil erosion. Impacts that create new trails, particularly through chaparral and coastal sage scrub, can effectively increase the "edge" within the reserves by expanding the foraging range of cats and other mesopredators and creating dispersal corridors for commensal animals.

E. Physical Impacts

Increases in nighttime illumination and in sound and vibration levels from surrounding residential development and roadways may directly affect wildlife activity along the urban/wildland interface at the periphery of the Preserves. Increased light levels at night

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reduce habitat for nocturnal animals, which has been demonstrated in San Diego County by reduced nocturnal:diurnal snake capture ratios near developed areas (Fisher 2001). Noise levels above 60 A-weighted decibels are considered by regulatory agencies to interfere with nesting success of coastal California gnatcatcher and least Bell's vireo, and may affect other bird species.

These impacts are relatively minor in scale, impacting only the periphery of the Preserves with adjacent residential development or roads over a width on the order of 100 feet.

F. Measures to Reduce Edge Effects

1. Biologically Mediated Impacts

Control of predation by domestic and feral cats and other mesopredators (referred to hereinafter simply as cats) is of primary importance in maintaining wildlife populations over the next century. Both natural and human factors can minimize predation upon wildlife. Both Preserves are connected to extensive open space by wildlife corridors, which should effectively maintain coyote, and possibly bobcat, presence in the Preserves. If these corridors continue to function, top predators are likely to limit cat numbers so that extirpation of wildlife species from the Preserves would be unlikely over the medium term.

Cats are likely to continue to prey upon small mammals and birds, however, reducing their numbers below their current levels. Efforts to affect human behavior could further reduce the presence of cats on the Preserves, and maintain wildlife populations. These efforts include:

- Public education to promote top predators as "keystone species" of the natural world, rather than as "varmints" degrading the quality of suburban life. This would be implemented through signage and field trips within the Preserves and educational packets for schools and community groups.
- Community covenants and restrictions prohibiting cats outside of dwellings (possible for multi-family housing adjacent to Carmel Mountain) or requiring that cats wear bells. Effectiveness of these rules would depend on public understanding of the detrimental effects of cats on wildlife, and public education measures, such as those described above, would be also needed.
- Fencing the edges of development with a fence type that cats cannot cross, such as concrete walls that are too high for them to jump onto.

Although cats are predators on many commensal animals that may compete with wildlife for food and serve as disease vectors, maintenance of an intact trophic structure, including top predators, should be no less effective in keeping population levels of these animals in check.

Maintenance of sanitation within the Preserves (e.g., providing closed trash receptacles in all areas used by humans) is the primary Preserve management tool to maintain low population levels of commensal animals. Insanitary conditions are not expected in surrounding residential areas, but information on potential increases in rat and mouse populations with improper sanitation could be included in public education activities.

Long-term population increases by commensal animals and concomitant population decreases by small wildlife species would be observed by Preserve monitoring programs. Trapping and eradication efforts would be necessary as an adaptive management response if this is observed.

Educating the public on the adverse impact of invasive exotic species, particularly pampas grass and other ornamental plants, should also be part of community education. Volunteer efforts to control exotics within the Preserves should be encouraged, with the recognition that these efforts will be of primary benefit to long-term habitat quality

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by increasing the level of community appreciation of native species and natural ecological processes. Eradication of exotic plant species should be regarded as a secondary outcome of volunteer activities, and will most likely depend upon efforts of Preserve staff for effective, coordinated implementation.

A monitoring program to measure species composition around the preserve edges can be established by setting up repeat photography points around the edge perimeter. Repeat photography, if done in a consistent manner, offers an inexpensive and detailed chronicle of changes in vegetation and species composition. Establishing transects and sampling vegetation is another effective method to measure the changes related to edge effects. An eradication, restoration, and enhancement program would be necessary as an adaptive response if a change in species composition is observed.

2. Direct Human Impacts

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A combination of public outreach, directing impacts to areas of marginal habitat value, and vigorous enforcement of infractions is recommended to minimize the adverse effects of human use of the preserves.

Public outreach efforts should include signs within the preserve illustrating the destructive effects (erosion, exotic invasive plants) of unauthorized activities; outreach to community groups, including mountain bicycle outlets and associations; and outdoor classroom programs.

Trail closures discussed in this management plan will reduce impacts to high-value resource areas. Adequate staffing is needed, however, to enforce restrictions on use of the Preserves. Paid staff may be augmented by trained volunteers "deputized" to enforce Preserve regulations. Properly educated hikers and mountain bicyclists could provide dedicated and effective vigilance that would have a far greater presence throughout the Preserves than could be provided paid staff alone.

Chapter Seven

Habitat Linkage and Wildlife Corridors

Habitat linkages and wildlife corridors are defined as areas that connect suitable wildlife habitat areas in a region otherwise fragmented by rugged terrain, changes in vegetation, or human disturbance. Natural features such as canyon drainages, ridgelines, or areas with vegetation cover provide corridors for wildlife travel. Habitat linkages and wildlife corridors are important because they provide access to mates, food, and water; allow the dispersal of individuals away from high population density areas; and facilitate the exchange of genetic traits between populations. These areas are considered sensitive by the City of San Diego and resource and conservation agencies. The MHPA has been determined to provide the necessary connectivity to provide habitat linkage and wildlife corridors to allow for the long-term survival of plants and wildlife within the region.

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A. Functional Corridor Characteristics

Specific characteristics for a functioning wildlife corridor are detailed in the wildlife management plan for Torrey Pines State Reserve (1997), taken from a 1992 study of corridors in San Diego County (Ogden 1992). The following describes those parameters detailed in that plan.
Firstly, the corridor must link two or more areas of habitat, the corridor must direct animals safely to an area of suitable habitat, without leading them into a "mortality sink," or an unsuitable habitat with high risk of mortality. Finally, the design of the corridor must permit species to utilize the corridor frequently enough as to facilitate exchange of genetic traits between populations of different demographics. A functional corridor is typically well vegetated, is more than 500 feet wide at the narrowest region, and water is present year round. If an underpass is present, they are well covered with vegetation and noise levels are within 40-56 decibels. Some underpass structures were found to have decreased numbers of road kills. Bridge type underpasses had the lowest mortality rates, while mortality rates increased for pipe culverts, box culverts, and interchanges. When evaluating the potential for a new corridor, these factors should all be taken into consideration.

B. Corridor Size and Structure

Functional corridor widths are suggested to be no less than 500 feet. As determined by the topography, this excludes buffer zones. A 250-foot buffer of native vegetation on both sides should be implemented (MSCP; City of San Diego 1997). This aids in concealment of animals, and making human encroachment difficult. The best corridors utilize the entire topographic feature (such as a canyon), this deters the animals from ascending slopes. When this is not a

possibility, and traversing urban development is occurring, the corridor width must be larger with more extensive native vegetation.

As stated previously, corridors function best when located in a topographic feature, and are well vegetated within and along the outer edge. A water source should be available year around, preferably containing a riparian strip. Because animals typically use the path of least resistance, a dirt trail should be established. In order for animals to traverse safely through an underpass, 10-foot fencing should be implemented to restrict animals from jumping, or losing their path to desired habitat. Such fencing must be maintained in order to be effective. When an underpass is an unavoidable option, the best are those that are unlit, well-vegetated, with a bridge-like structure. When mountain lions are present, culverts are not recommended, as they do not prefer to use them. Human encroachment, including transient presence, should be minimized. The corridor should not become a mortality sink, by leading into a "habitat cul-de-sac." When part of the corridor is in contact with human recreation, sufficient cover should be implemented for animals to remain concealed. Business parks in the vicinity should also be well vegetated with native plants to lessen the view of the structures, and securing a safe passageway for animals.

C. Corridors in San Diego County

The northern area wildlife corridors include linkages to the core areas of Del Mar Mesa Preserve, Los Peñasquitos Canyon Preserve, Los Peñasquitos Lagoon, Torrey Pines State Reserve, San Dieguito River valley, and Black Mountain Park (Figure 7-1). The Carmel Mountain area provides a substantial link for the movement of animals between inland natural areas like the Los Peñasquitos Canyon Preserve and the coastal natural areas like Torrey Pines Reserve.

Corridor linkages existing between the Del Mar Mesa Preserve and surrounding areas include Deer Canyon to the northern border of the preserve that connects with the Santa Monica Ridge. The Santa Monica Ridge is bordered to the north by McGonigle Canyon. This corridor facilitates passage onto Black Mountain Park. Continuing eastward from Deer Canyon is the Carmel Valley. This corridor will be linked to the Gonzales Canyon in the future. RECON is in the process of revegetating that wildlife corridor and facilitating the movement of wildlife. Travelling south of Carmel Valley is a corridor that connects with the southwest corner of Del Mar Mesa Preserve, which feeds into Los Peñasquitos Canyon Preserve. Neighborhood 10 impedes movement of wildlife from Los Peñasquitos

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Carmel Mountain Preserve
Del Mar Mesa Preserve
Wildlife Corridor

FIGURE 7-1

Wildlife Corridors

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Canyon into Carmel Mountain directly, but there are a couple of entrances via the southeast corner of Carmel Mountain Preserve, and from using the Carmel Country Road wildlife tunnels, which access Carmel Mountain on the northeast corner via Shaw Valley. The major connections between the Carmel Mountain Preserve to Torrey Pines State Reserve is restricted mainly to a few narrow routes along Sorrento Valley Road, Carmel Valley Road, and Carmel Mountain Road.

The Sorrento Valley corridor is outside of the Carmel Mountain and Del Mar Mesa Preserves; however, it is an important linkage between the coastal and inland areas of San Diego. The Sorrento Valley corridor was the only functional wildlife corridor to areas outside of the Torrey Pines Reserve in Crooks' 1997 study. A corridor previously labeled as functional by Ogden (1992), the Carmel Mountain corridor no longer appears to be used, apparently due to construction and development over the last five years. No evidence of the use of the Sorrento Valley corridor by mule deer, bobcats, or mountain lions was found in 1992. The pressure of the development of Carmel Mountain Road has likely been the cause of their "switching" to the Sorrento Valley linkage.

At least two routes are used by predators and mesopredators through the Sorrento Valley corridor. The northern route starts at the west end of Los Peñasquitos Canyon, passes under I-805 and I-5, goes along the lawn south of the business complex on Sorrento Valley Road, passes under Sorrento Valley Road, and ends in Los Peñasquitos Lagoon. The southern route starts on the east side of Los Peñasquitos Canyon and passes under I-805 and I-5, goes under Sorrento Valley Road, and ends in Los Peñasquitos Lagoon. Both routes follow the natural riparian channel between Los Peñasquitos Lagoon and Los Peñasquitos Canyon.

Six species have been found to use the Sorrento Valley Wildlife corridor. All species use both routes within the corridor. Bobcats and coyotes use the corridor several times a month, while evidence of the coyote, fox, and raccoon are found almost nightly. Opossums and skunks frequently use the wildlife corridor. No deer tracks were found, and this is likely due to the low underpass limiting the use of the corridor by deer. No mountain lion tracks were found either; however, this may be due to the fact that the duration of past surveys was too short to register a rare event.

As the only functional corridor between the Torrey Pines State Reserve and other core areas, the restoration and protection of the Sorrento Valley corridor is vital. A number of management measures to ensure the functionality of the Sorrento Valley, not only for the species currently utilizing it, but for the mountain lion and mule deer as well, are outlined in Crooks (1997).

The Carmel Valley Corridor was functional for mountain lion, bobcat, coyote, and fox in 1992 (Ogden 1992). It was not thoroughly surveyed by Crooks in 1997 because the freeway was under construction. Crooks (1997) recommends that current construction plans be analyzed and construction be monitored to ensure a functional corridor is created. Two I-5 bridges have been constructed over the Carmel Valley Creek channel. These parallel bridges measure approximately 8 feet high and 40 feet wide, and together they cover an over 200-foot stretch of the creek. It has not yet been determined if wildlife accepts this underpass as a viable route of travel, or if it is now or will remain accessible to wildlife.

The Carmel Mountain underpass was used by deer, mountain lions, bobcats, and coyotes in 1992 (Ogden 1992), but it is no longer functional. In 1992, wildlife could travel west from Del Mar Mesa, down Carmel Mountain Road, then across a small dirt road. West of the I-5 underpass, the corridor turned north and followed a narrow coastal sage scrub berm between I-5 to the east and an industrial park to the west. At the north end of the industrial park, the corridor turned west and followed a chaparral vegetated ravine to Sorrento Valley Road. Animals crossed the two-lane road and railroad tracks before entering Peñasquitos Lagoon and the main reserve. It is likely that this corridor has been

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permanently severed due to additional office development on the west side of I-5, widening and paving Carmel Mountain Road through the underpass, and current housing construction on the east side of I-5.

The existing Environmental Impact Report for Carmel Valley Neighborhood 10 (Neighborhood 10) (RECON 1994) displays an open space corridor from Los Peñasquitos Canyon running northeast to Carmel Mountain. This corridor is intended to provide a critical avenue for wildlife movement between Los Peñasquitos Canyon and McConigle Canyon/Carmel Valley to the north. Several sensitive reptile, mammal, and bird species currently utilize this corridor to meet their foraging and home range requirements. When development of Neighborhood 10 and Sorrento Hills planning area is completed, this will be one of the only remaining corridor linkages designated as open space. Without this connection, wildlife movement between Carmel Valley and Los Peñasquitos would decrease dramatically, resulting in increased fragmentation of many sensitive populations.

The Del Mar Mesa (Subarea V) Specific Plan EIR (City of San Diego 1996) addresses that the Del Mar Mesa Preserve area is considered to be a high value core habitat area. Adjacent to this area, south of the preserve, lies Los Peñasquitos Canyon Preserve. Los Peñasquitos Lagoon and Torrey Pines State Reserve lie a few miles to the west, via Carmel Valley. In addition, lands to the north currently provide habitat and wildlife movement capability, including the San Dieguito River valley and Black Mountain Park.

The City of San Diego, along with a number of wildlife conservation groups and agencies, recognize the Del Mar Mesa as an important area that allows wildlife movement between Los Peñasquitos Canyon and Deer Canyon, McGonigle Canyon, Carmel Valley, and open space areas to the north, west, and east. According to the Del Mar Mesa (Subarea V) Specific Plan EIR (City of San Diego 1996), the movement of animals is not confined to narrow corridors. Several large mammals use many of the dirt roads, such as mule deer, coyote, bobcat, mountain lions, as well as smaller animals. Birds are unrestricted, and have access to all portions of the site that suit them. Regions that funnel wildlife movement in Subarea V, include the north-south trending canyons and tributary drainages to Los Peñasquitos Canyon, Carmel Valley, Deer Canyon, and Shaw Valley. Deer Canyon is considered a major corridor because of its relative isolation from disturbance and its water sources.

The City of San Diego MSCP Subarea Plan (1997) recognizes this core resource area encompasses one of the few intact natural open space areas in coastal San Diego County that is still linked to larger expanses of habitat towards the east.

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